

6. Seabird research on Cape Shirreff, Livingston Island, Antarctica, 2001-2001; submitted by Iris M. Saxer, Dana A. Scheffler, and Wayne Z. Trivelpiece.

6.1 Objectives: The austral summer of 2001-2002 marked the fifth season of land-based predator research conducted by the United States Antarctic Marine Living Resources (AMLR) program at Cape Shirreff, Livingston Island, Antarctica (62°28'S, 60°46'W). Through long-term monitoring of krill predator populations, our research on Cape Shirreff contributes to U.S. participation in the international CCAMLR (Convention for the Antarctic Marine Living Resources). Our objectives for the 2001-2002 seabird season were:

1. To estimate chinstrap and gentoo penguin breeding population size (CCAMLR Ecosystem Monitoring Program (CEMP) Standard Method 3a);
2. To band 500 chinstrap and 200 gentoo penguin chicks for demography studies (CEMP Standard Method 4a);
3. To determine chinstrap and gentoo penguin foraging trip durations during the chick rearing stage of the reproductive cycle (CEMP Standard Method 5a);
4. To determine chinstrap and gentoo penguin breeding success (CEMP Standard Methods 6a, b & c);
5. To determine chinstrap and gentoo penguin chick weights at fledging (CEMP Standard Method 7c);
6. To determine chinstrap and gentoo penguin diet composition, meal size, and krill length frequency distributions via stomach lavage (CEMP Standard Methods 8a,b & c);
7. To determine chinstrap and gentoo breeding chronologies (CEMP Standard Method 9).

6.2 Accomplishments: We opened the Cape Shirreff field camp on 14 November 2001 with the assistance of the National Science Foundation (NSF) vessel *R/V Nathaniel B. Palmer*, which provided logistical support and transit from Punta Arenas, Chile to Cape Shirreff. On 15 January 2002, two additional scientists arrived aboard the U.S. AMLR-chartered vessel *R/V Yuzhmorgeologiya* and one more scientist joined the crew on 5 February 2002. Research continued until camp closure on 10 March 2002. Return passage from Cape Shirreff to Punta Arenas, Chile was provided by the *R/V Yuzhmorgeologiya*.

6.3 Results and Tentative Conclusions:

6.3.1 Breeding Biology Studies: The penguin rookery at Cape Shirreff is comprised of 28 active breeding colonies: 13 chinstrap penguin (*Pygoscelis antarctica*) colonies, seven gentoo penguin (*P. papua*) colonies, and eight colonies with both penguin species. To determine penguin breeding population size, we counted all breeding pairs in all breeding colonies approximately one week after the peak clutch initiation date for both species. Gentoo penguins were censused on 23 and 24 November and chinstrap penguins on 29 November and 1 December 2001. A total of 907 gentoo and 6,606 chinstrap penguin pairs bred at Cape Shirreff in 2001/02. Penguin

populations have been censused at Cape Shirreff annually since 1997/98. The 2001/02 population counts represents the lowest chinstrap penguin count on record. The gentoo penguin population was down considerably from last year, but was within the five-year averages.

We determined reproductive success by banding and following a sample of 100 chinstrap and 50 gentoo penguin pairs from the start of egg laying until the chicks entered crèches. The mean nest initiation date for chinstraps was 20 November and ranged from 16-30 November. Gentoo penguins on average nested earlier, with a mean clutch initiation date of 7 November and a range from 25 October to 22 November. Gentoo penguin pairs nesting in colonies on the west side of the Cape Shirreff peninsula laid eggs two weeks earlier than east side pairs, possibly due to earlier availability of snow-free nest sites. Mean clutch initiation date for the west colonies was 1 November and east colonies was 15 November. All gentoo penguin census and weighing dates were adjusted to account for this disparity. Mean chinstrap penguin clutch initiation dates coincided exactly with dates from the past two seasons; however, gentoo penguins laid eggs a mean ten days early than previous seasons. Chinstrap penguins hatched 0.97 chicks per pair and fledged 0.73 chicks per pair. Seventy-five percent of all chicks that hatched survived to fledging. Gentoo penguins had significantly higher reproductive success during the 2001/02 season, hatching 1.66 chicks per pair and fledging 1.32 chicks per pair. Eighty percent of all chicks that hatched survived to fledging. Chinstrap penguin reproductive success in 2001/02 was the lowest on record for Cape Shirreff, while gentoo penguin reproductive success was within the five-year averages. This season we had a significant increase in the number of known-age chinstrap and gentoo penguins breeding. These birds were banded as chicks at Cape Shirreff and have returned to their natal colonies to breed. Thirty known-age chinstraps and eleven known-age gentoo penguins attempted to breed, although only ten chinstrap and two gentoo penguin pairs successfully fledged chicks.

We conducted the annual chinstrap penguin chick census on 8-9 February. Gentoo penguin chicks were censused on 20 January and 3 February to account for the two-week difference between the west and east side colonies' clutch initiation dates. A total of 7,432 chinstrap and 1,061 gentoo penguin chicks survived to crèche age this breeding season. This season represented a 23.7% decline for chinstrap penguins and an 18.3% decline for gentoo penguin chicks, compared to the 2000/01 counts.

As part of our ongoing demographic study, we banded a sample of 500 chinstrap penguin chicks on 10 February, and 200 gentoo penguin chicks on 25 January and 7 February. We will continue to collect future demographic data on these and other known-age birds as they return to the rookery to establish territories, select mates and breed.

From 15-23 February, we captured and weighed a sample of 256 chinstrap penguin chicks as they congregated on rookery beaches in preparation for fledging to sea. The mean chinstrap penguin chick fledging weight for the season was 3,202g, which is slightly higher than last year but comparable to other years. We also collected 85-day weights for gentoo penguin chicks. Gentoo penguins do not fledge in the traditional sense. They continue to receive supplemental feedings by their parents during their early at-sea foraging trips. We therefore obtain comparable weights 85 days after the peak clutch initiation date. Chicks are approximately seven weeks old at this time, the age at which the other two species of *Pygoscelis* penguins fledge. We weighed

125 gentoo penguin chicks on 25 January and 75 chicks on 7 February. The mean weight for this sample was 4494g, down slightly from last year's gentoo penguin chick weights.

6.3.2 Foraging Ecology Studies: We collected 40 chinstrap and 20 gentoo penguin diet samples between 6 January and 18 February 2002 to determine meal size and prey composition of food delivered to chicks by foraging adults. All sampled adults were verified breeders as individuals were captured at the nest site just before feeding their chicks. Stomach contents were removed by lavaging, sorted into prey types and weighed to the nearest 0.1 gram. The dominant prey species in the diet samples was krill (*Euphausia superba*), which we found in 100% of samples from both chinstrap and gentoo penguins. Chinstrap penguin diets were composed almost entirely of krill with only 15% of samples containing otoliths or trace amounts of fish. Gentoo penguins consumed more fish with 70% of the diet samples containing some portion of fish in addition to krill. We used otoliths collected from samples to identify fish species in the diet. Analysis of length-frequency distribution of krill in the penguins' diets revealed a wide range of krill size classes from 18mm to 63mm with approximately 10-26% of krill in each of five CCAMLR size classes: 31-35mm, 36-40mm, 41-45mm, 46-50mm, and 51-56mm. This is a shift from the past four seasons where penguin diets have shown a distinctive peak of 40-50% of all krill in one CCAMLR size class (Figure 6.1). This peak is believed to represent the strong 1994/95 krill cohort that has dominated the diets of penguins at Cape Shirreff in the four previous years and may be dying off now.

To determine penguin foraging trip durations throughout the chick-rearing phase, we attached radio transmitters to 19 adult chinstrap penguins and ten gentoo penguins with week-old chicks. We tracked their foraging trips from the first week in January until the chicks fledged in late February. All data were received by a remote antenna and stored by a field computer located at our bird blind in the penguin rookery. Mean foraging trips were 12.2 hours during the chick-rearing period this season, a significant increase over the 8-9 hour trip lengths in the 2000/01 season. Results of our satellite tagged birds revealed that the birds were foraging farther offshore than in the previous season, a pattern likely to account for the longer trip lengths we found in 2001/02 (see paragraph below).

To gather additional at-sea foraging data, we outfitted ten chinstrap penguins with ARGOS satellite-linked transmitters (PTTs) during the early chick-rearing phase and four gentoo penguins in the late chick-rearing phase. On 15-16 January, we deployed ten PTTs on adult chinstrap penguins to determine adult foraging locations while chicks were about three weeks old, just prior to crèche. The timing of this deployment coincided with the annual AMLR marine prey survey conducted in adjacent ocean waters. The PTTs remained on the birds for approximately 10 days before removal. We plotted at-sea foraging positions of chinstrap penguins using Surfer software and found that birds were traveling up to 30km offshore to feed at the shelf break in January 2002. This represents a very different foraging pattern from data gathered during the 2000/01 January period, when all penguin foraging activity was confined to the shelf area within 10km of the colony. On 16 February, we redeployed four PTTs on gentoo penguins with 7-8 week-old chicks to track later season foraging locations. This timeframe coincided with the AMLR nearshore hydroacoustic survey of Cape Shirreff. Gentoo penguin foraging patterns were well inshore of the Chinstrap foraging areas used a month earlier; and all birds foraged within 15km of the colony. Detailed analyses of both species foraging patterns during the last three seasons are under way. In addition, one PTT was not retrieved from the

final deployment and remained on a gentoo penguin throughout its 2-3 weeklong pre-molt foraging trip. This is the first time data have been collected on gentoo penguin foraging behaviors during the pre-molt period.

To study penguin diving behavior during the chick-rearing phase, we placed eight time-depth recorders (TDRs) on adult chinstrap and gentoo penguins with chicks. The timing of both deployments (10 and 21 January) coincided with the AMLR marine prey survey. The TDRs gathered data on variables such as the dive depth, duration, time, and sea temperature. We are currently analyzing data on penguin diving profiles collected by the time-depth recorders.

In addition to our penguin research, we studied the breeding biology of the brown skua (*Catharacta antarctica lonnbergi*). Brown skuas are key predators on the Cape Shirreff penguin population. Penguin eggs and chicks provide a major food source for brown skuas during the breeding season. Throughout the season, we followed the reproductive success of all brown skua breeding territories (n=19) on Cape Shirreff and one territory off the cape. Brown skua reproductive success was lower this year than in previous years with 1.25 chicks hatched per pair and .95 chicks fledged per pair. We have banded all breeding brown skuas in previous seasons. In 2001/02, we banded one new adult female and all chicks born this year and collected measurements of culmen length and depth, tarsus length, and weight. Brown skua chicks begin returning to their natal grounds as three-year-olds. We began banding chicks in the 1996/97 austral summer. The number of returning known-age skuas at Cape Shirreff is slowly increasing each year with six known-age birds observed in 1999/00 and twelve observed in 2000/01. During the 2001/02 season we resighted a total of 14 known-age skuas, although only four of these were first time observations. We also followed reproductive performance of kelp gulls (*Larus dominicanus*) opportunistically throughout the season.

6.4 Future Research: Our future research plans include the continuation of the annual CCAMLR predator monitoring protocols and at-sea foraging behavior studies with TDRs and PTTs. These methods, in association with the Antarctic fur seal research at Cape Shirreff, and the annual AMLR marine prey survey, will allow us to further investigate and gain insight on the seasonal and inter-annual variability of the krill and predator populations in this region.

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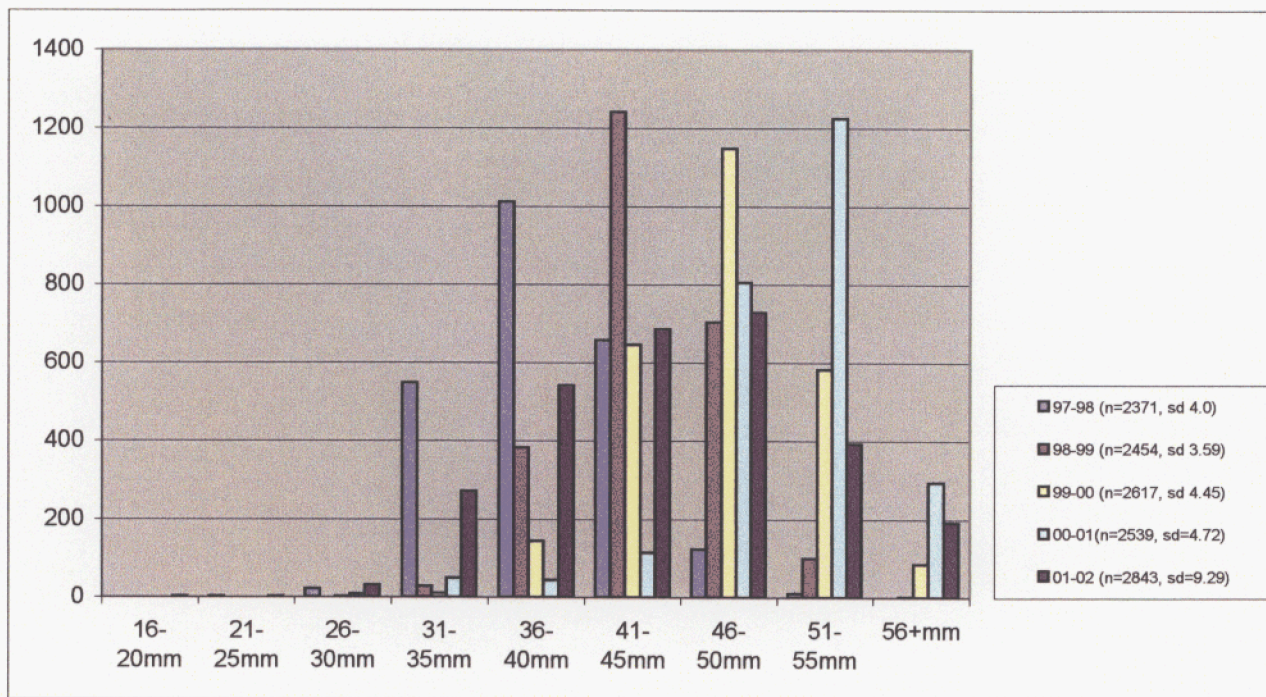


Figure 6.1. Krill length-frequency distribution from chinstrap and gentoo penguin diet samples at Cape Shirreff, Livingston Island, Antarctica 1997-2002.